

Rick Hance Engineering Note

Date: 8/17/2000

Rev Date: 8/31/2000

Project: General Support

Doc. No: H000817A

Subject: Safety Review Documentation for HV System in SiDet 10% Test

Location: The high voltage system for the SiDet 10% test is contained in a single equipment rack located in the NE corner of the SiDet 10% test Area in the Lab C clean room as shown in figure 1. All of the equipment is in the form of VME HV modules containing high voltage "pods" and supporting VME infrastructure as shown in figure 2. The VME HV modules and pods were developed at Fermilab for Dzero Run I, and are now commercially available from BiRa Corporation. The SiDet installation uses Fermilab and BiRa components interchangeably.

AC Distribution: AC power for this temporary installation is supplied to the rack via a 25' extension cord plugged into a 208V 30A 3ph outlet on the west side of the room¹. The 5-wire AWG 10 extension cord is routed overhead and supported by appropriate hangers. An AC distribution box mounted in the HV rack derives three 120V 1ph circuits and distributes them through 15A circuit breakers to outlets for the four VME power supplies PS-1 through PS-4 as shown in figure 3. Each VME power supply has a suitable fuse in its AC input circuit. The entire rack uses $\approx 6A$ per phase (2.2 kVA) from the 208V input².

DC Distribution: The four VME power supply assemblies PS-1 through PS-4 are shown in figure 4. They provide DC power to the four VME crates. These power supply assemblies are provided as complete packaged units by LAMBDA³. The assemblies are connected to the VME crates by harnesses designed to carry the maximum available currents from the power supplies⁴.

Module Fusing: Each VME HV module uses 5 separate voltages from the VME backplane (+5V, $\pm 12V$ analog, $\pm 12V$ bulk). The +5V and the $\pm 12V$ bulk use multiple VME pins in parallel as required to limit the current density to acceptable values. Each voltage is fused near the VME input connector as shown in figure 5.

Cooling: Forced-air cooling is provided by fans located under the VME crates and the Lambda power supplies. Whereas water cooled heat exchangers are normally used in the Dzero high voltage installations, the worst case operating conditions of this particular installation do not require it⁵.

Fire Protection: The relay rack is fitted with side panels and rear door. The AC inputs in the four VME power supply assemblies are interlocked⁶ to a smoke detector located in the top of the rack as shown in figure 6.

Discussion: The rack contains a total of 84 positive and 84 negative programmable high-voltage pods (channels)⁷. The pods are distributed over 22 VME modules plugged into four VME crates.

The Type 1 and Type 2 pods are rated at 5.5kV @ 2.0mA and -5.5kV @ 2.0mA respectively. However, for use with silicon detectors, the pods are limited to 100V @ 2.0mA and -100V @ 2.0mA via the front panel, screwdriver adjustable, HVmax potentiometer feature of the devices. The HV system is controlled by a software program via an ethernet connection and commercial processor modules located in each crate. The pods are operated at 60-80V for the test. The HV is extracted from the module's front panel connectors via red RG-58 cable with SHV connectors. The cables go to the HV patch panel rack shown in figure 1. From there, the HV is fanned out into twist-n-flat cable (AWG 28, 300 Vdc, 105°C). The twist-n-flat cable routes the HV to the interface rack shown in figure 1 and from there it is delivered to the detector.

Shock Hazard: The Dzero HV system has been extensively analyzed and reviewed for safety with respect to shock hazard⁸. In the worst case Dzero configuration at a maximum available voltage (5.6 kV), with extensive capacitive cabling (20, 135ft cables in parallel), the maximum current available with respect to time is well within safe levels. This particular installation, with its voltage and current limit of 100V and 2mA respectively, and its short lengths of capacitive cable presents minimal or no shock hazard.

FERMILAB ENGINEERING NOTE		SECTION	PROJECT	SERIAL-CATEGORY	PAGE
SUBJECT South End of Lab C Clean Room SiDet 10% Test Area General Layout of Area with Location of HV Rack			NAME R. Hance <hr/> DATE 8/18/00 REVISION DATE		

North

HV Rack

Low Mass
to Shielded
Transition

Interface

VRB
(Readout)

Sequencer

Level III

HV Patch
Panel

10%
Detector

Table

Cabinet

Table

Table

HV Rack

Figure 1

FERMILAB ENGINEERING NOTE		SECTION	PROJECT	SERIAL-CATEGORY H000320A	PAGE 1
SUBJECT General Configuration of SiDet 10% HV Rack			NAME R. Hance		
			DATE 3/20/00		REVISION DATE

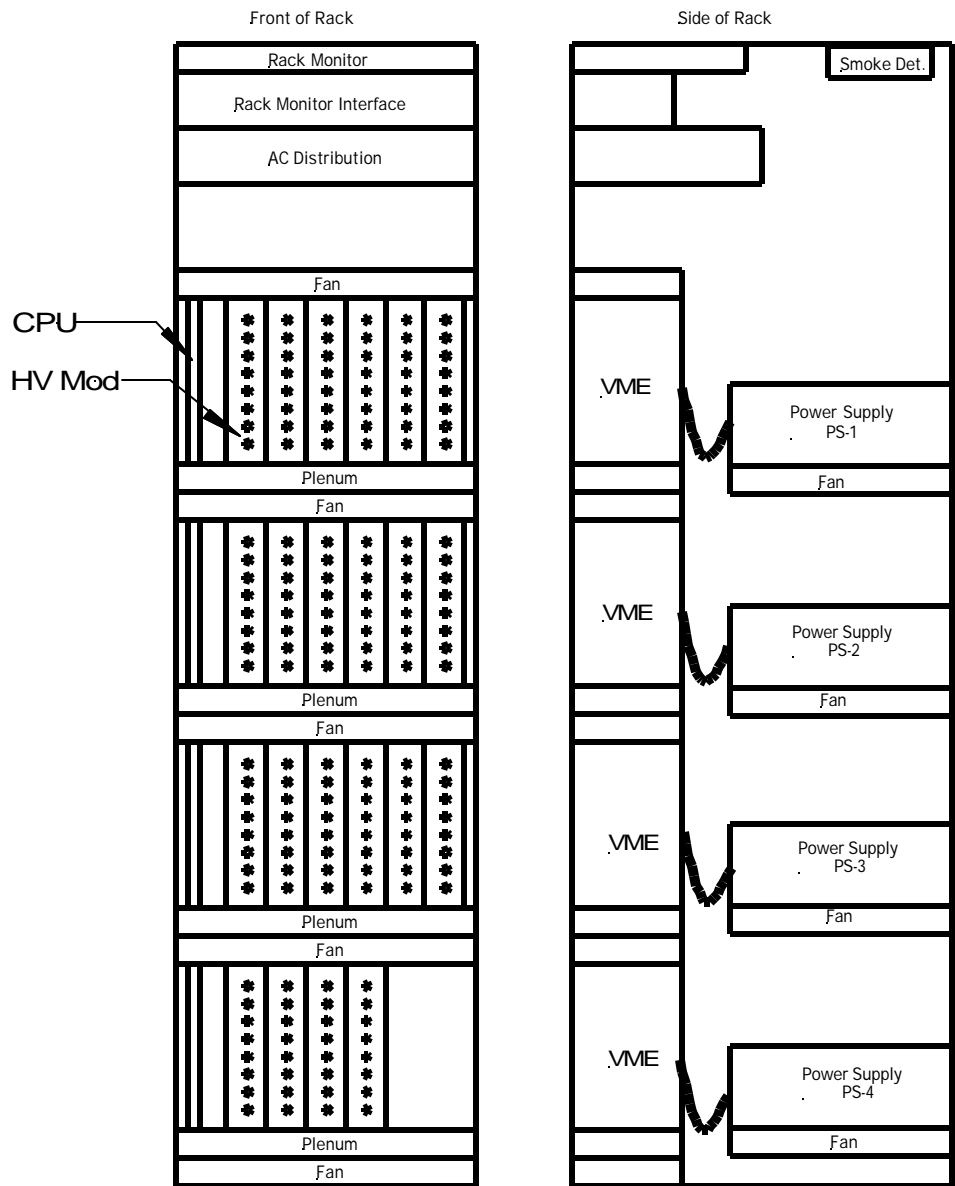
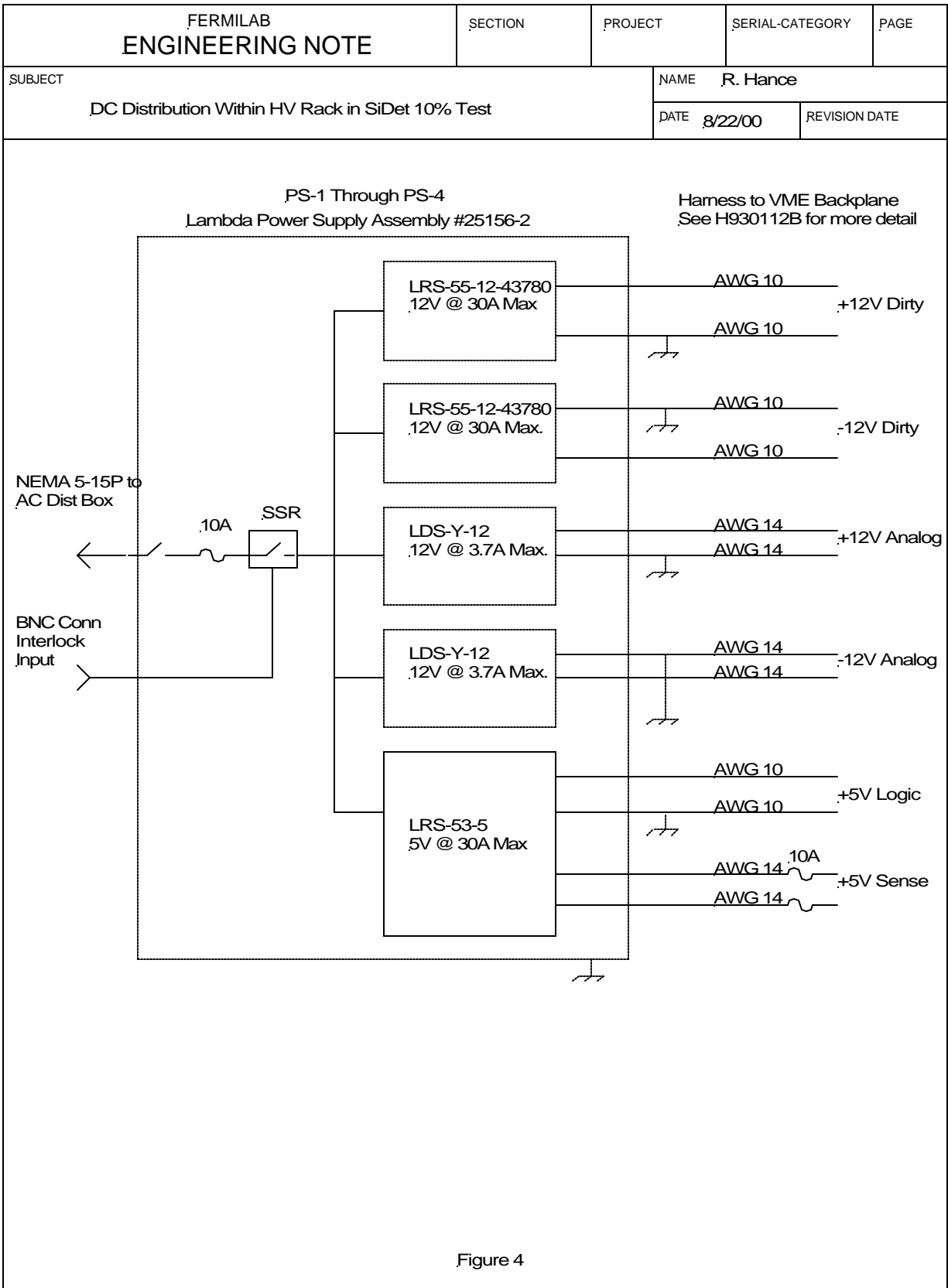


Figure 2



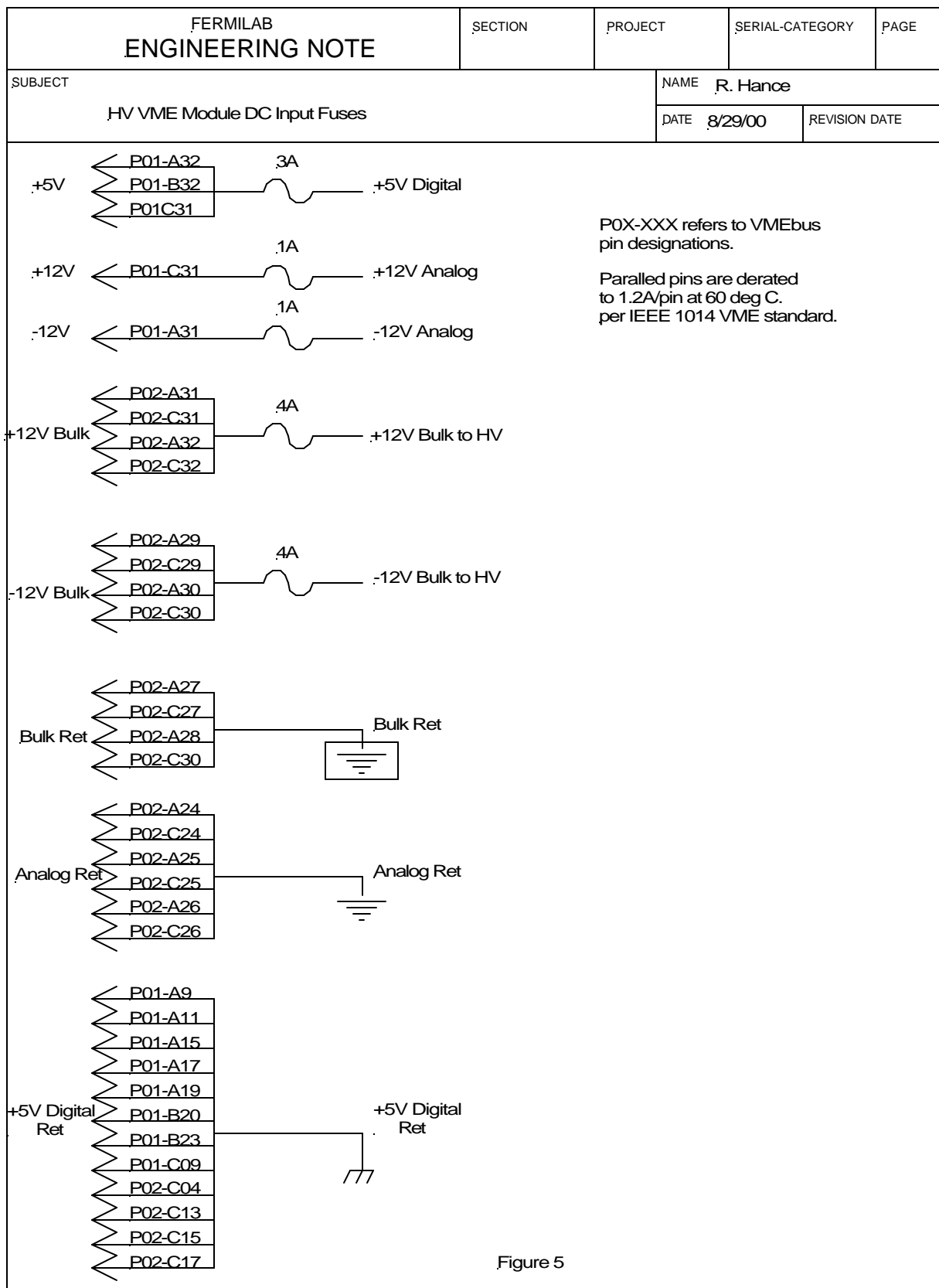
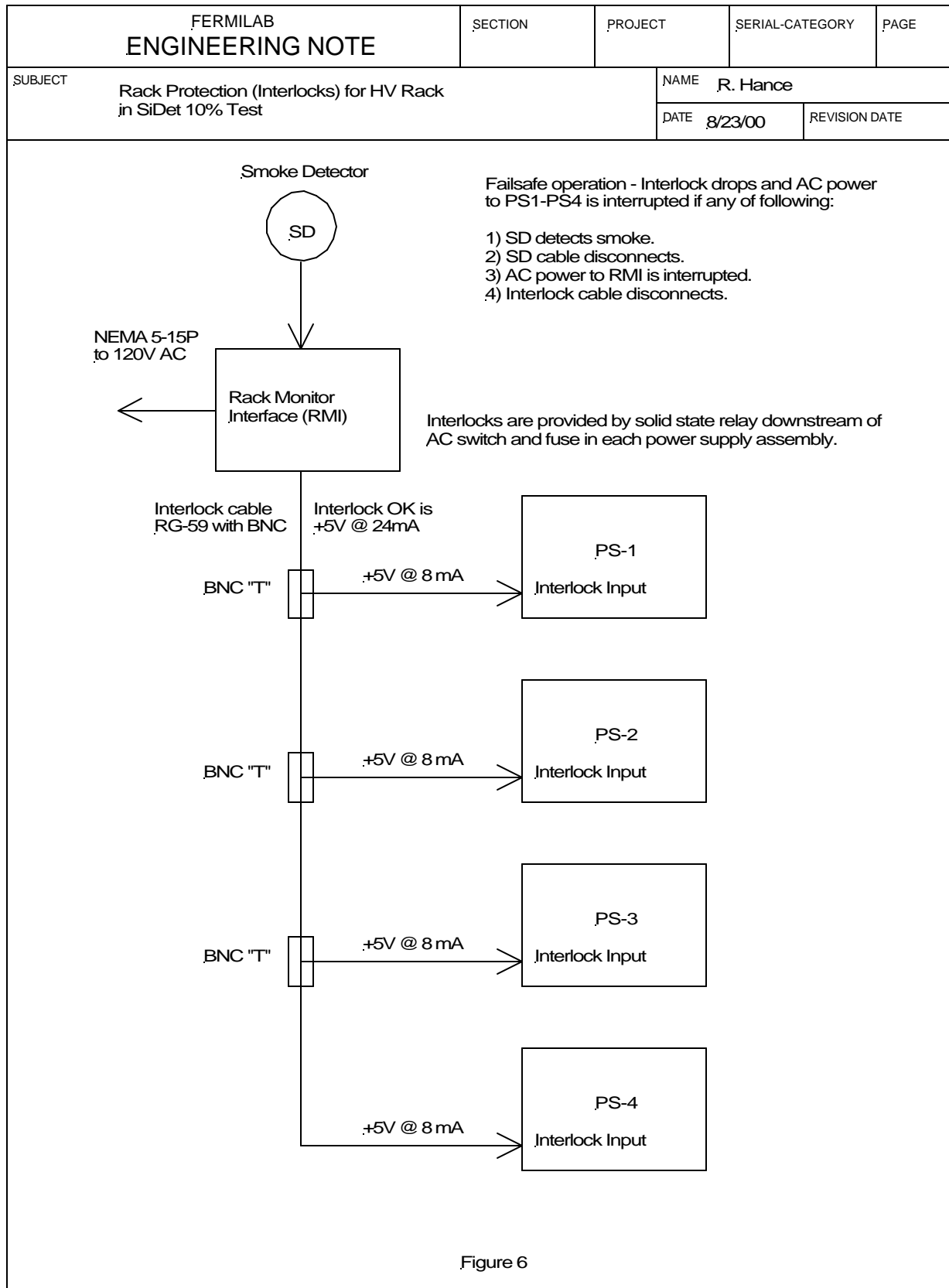


Figure 5



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- ¹ Supplemental documentation available on request: Engineering Note, Rick Hance, H000403A, "HV Rack extension cord for sidet 10% test at Lab C".
- ² Supplemental documentation available on request: Engineering Note, Rick Hance, H000410A, "AC Requirements for HV Rack Installation at Sidet 10% Test".
- ³ Supplemental documentation available on request: LAMBDA power supply manual, ASSY #25156-2.
- ⁴ Supplemental documentation available on request: Engineering Note, Rick Hance, H930112B, "Wire Harness for Low Voltage Power Supplies in Dzero HV Crates".
- ⁵ Supplemental documentation available on request: Engineering Note, Rick Hance, H990806A, "Efficiency of HV Pods for SiDet" and Engineering Note, Rick Hance, H000320A, "HV System for Sidet 10% Test" (cooling calculations).
- ⁶ Supplemental documentation available on request: User Manual, Rick Hance, "Dzero Rack Monitor Interface Chassis".
- ⁷ Supplemental documentation available on request: User Manual, BiRa Systems, "Model VME 4877PS High Voltage Power Supply System Manual 2nd Edition March 1998". Also Hardware Manual, BiRa Systems, "High Voltage System VME-Based Model 4877, 3/24/00"
- ⁸ Supplemental documentation available on request: Note, Marvin Johnson, "Safety Analysis of the D0 High Voltage System, June 1991".